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16. ABSTRACT The paper gives results of a study of civil engineering fabrics applied to fugitive dust problems. The fabrics, commonly used for ground stabilization, subsurface drainage, railroad construction and maintenance, sediment control, and erosion control, are available from Celanese, DuPont, Monsanto, and Philips Fibers under the trade names of Typar, Bidim, Supac, and Mirafi. Use of the fabrics for air pollution control is a recent development and the subject of recent and future tests. Emissions from unpaved roads are reduced by covering the roads first with the fabric and then with coarse aggregate. Unpaved parking lots, inactive piles, and construction sites could be controlled similarly. During November 1979 tests on an unpaved road constructed with Bidim, the average reduction in total suspended particulate was 58% and in inhalable particulate was 46%. More tests are planned.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Pollution Control	13B
Fabrics	Stationary Sources	11E
Dust	Fugitive Dust	11G
Leakage	Particulate	14G
Aerosols		07D
Roads		
Construction		13M

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Keeping dust under the carpet

BARRY LEVENE and DENNIS DREHMEL

In the arid regions of the western United States, local sources of fugitive dust appear to be the most significant contributors to ambient levels of total suspended particulate (TSP). These sources also contribute to the inhalable fraction, although to a lesser degree. Vehicles traveling on unpaved roads are a major source of these emissions, ranging from 54 percent of the total annual TSP emissions in Phoenix to 9 percent in Denver and 48 percent in Colorado Springs. An integral part of a particulate control plan is identifying fugitive emission control measures for unpaved roads. In addition to unpaved roads, construction sites, haul roads, and open areas within industrial sites are important contributors to TSP and may be sources of undesirable particulates such as lead.

Traditional control techniques to reduce unpaved road emissions such as paving, chemical stabilizers, watering, graveling, and traffic controls, have been analyzed in several studies. However, the use of a civil engineering fabric medium underlying the aggregate roadbed is a promising new technique which, after further study, may have application as an alternative control strategy in the western United States. It may, in addition, have other benefits such as reduced road maintenance. Fabric under aggregate may also be used to control unpaved parking lots, construction sites, and disturbed open areas. For these reasons the Environmental Protection Agency (EPA) Regional Office in Denver is assisting EPA's Industrial Environmental Research Laboratory at Research Triangle Park, NC in planning a study of the effectiveness of this type of road treatment on an unpaved road segment at the Ft. Carson Army Base near Colorado Springs, CO.

Even with the application of Reasonably Available Control Technology (RACT) on all stationary sources, many TSP nonattainment areas are projected to exceed the National Ambient Air Quality Standards (NAAQS) after the Clean Air Act's 1982 deadline. Control of the remaining nontraditional sources has presented a formidable planning task to those responsible for State Implementation Plans (SIPs). The problem has been complicated by the lack of definitive information on the cost effectiveness of the various control measures and the likelihood that a new inhalable particulate standard is in the offing. Few states or local governments are prepared to commit large amounts of public funds to projects of uncertain value in achieving the new inhalable particulate standards. The Colorado Air Quality Control Commission, in fact, has stated in policy paper 78-1 that it is not reasonable to gear a control program to meet a questionable standard and that it is the policy of the Commission to direct control efforts at the respirable fraction.

The EPA Administrator recognized these problems in his February 24, 1978 guidance on SIPs for nonattainment areas. This guidance states that after RACT for traditional sources, states could conduct demonstration projects and studies in lieu of adopted specific measures as long as the data on costs and benefits could be analyzed and strategies adopted and implemented in time to meet the 1982 deadline.

As SIPs were submitted in the months following January 1, 1979, it became apparent that most states had opted for the demonstration project alternative, although a few cities such as Phoenix and Colorado Springs committed to extensive paving programs which have since been delayed.

As a result EPA has provided further guidance on what should be the emphasis areas while the standards review is in progress. The first priority is to assure that RACT is applied to all traditional sources. The second is for those areas which have not yet done so to complete a problem assessment of sources, emission, and nature of particulate (size distribution in particular). EPA will be supporting several major studies of available control measures to determine source/receptor relationships, effectiveness, and air quality impacts.

EPA's Denver Regional Office has supported any such studies which may eventually lead to widespread implementation. Through a grant to the State of Colorado, a study is now being designed to conduct an evaluation of alternative snow control practices. The demonstration

Table 1. PROPERTIES OF CIVIL ENGINEERING FABRICS

	Brand Name			
	Monsanto Bidim	Celanese Mirafi	Philips Fibers Supac	DuPont Typar
Composition	polyester	polypro-pylene	polypropylene	polypro-pylene
Structure	spun-bonded	woven	heat bonded	spun-bonded
Thickness, mils	60-190	25	50	15
Weight, oz/yd²	---	4	5.3 (up to 16)	4
Grab strength, lb	115-610	200	150 (cross direction)	130
Burst strength, psi	225-850	325	300	---
Water permeability, cm/sec	0.03	---	0.05	---

Table 2. CONTROL EFFICIENCY OF ROAD CARPET (BIDIM) FOR TOTAL SUSPENDED PARTICLES

Date	Wind Speed, mph	% Reduction
11/7/79	0.6	60
11/9/79	2.4	59
11/14/79	0.3	30
11/16/79	0.2	70
4/28/80	7	35
4/28/80	7	44
4/29/80	8	36
4/29/80	9	39
Average		44

study of civil engineering fabric in unpaved roads fits in well with EPA guidance by providing an ideal opportunity to evaluate promising new technology.

Fabric description

There are at least four major manufacturers of civil engineering fabrics in the United States. These companies are Celanese, DuPont, Monsanto, and Philips Fibers. Some of their products are described in Table 1. Most manufacturers offer a range of properties according to thickness. Data in Table 1 should be interpreted as showing that generally the same range of properties is covered by all manufacturers. Usually civil engineering fabrics are sold for road stabilization, support, drainage, erosion control, or reinforcement. Such fabrics have been used under railroad tracks, riprap, and paved and unpaved roads. Fabrics are available in strengths to take loads from haul trucks and railroad trains, are rot resistant, and have been estimated to have a useful lifetime of 12 yr. The approximate 1980 cost was $1.00/yd^2$.

Test site

The test section is a 610-m (2,000-ft) segment of unpaved road located at the northern boundary of the Ft. Carson military installation south of Colorado Springs, Figure 1. There were several reasons for selecting Ft. Carson as the site. First, Ft. Carson officials were interested in cooperating in such an experiment. As a training center for ground-based artillery, the base contains long stretches of unpaved roads and cleared areas which are subject to fugitive dust emissions. For some time Ft. Carson has been considering conducting experiments with various dust palliatives to reduce these emissions. Base officials were most cooperative in assisting in site selection, providing monitoring equipment, and installing the fabric itself. In addition, the fabric had not yet been tested at a western site.

The road extends in an approximate north-south direction and provides access to several residential areas on the post. It is not in the training area, but is used mainly by Army personnel in light-duty vehicles enroute from or to these residences. An occasional track vehicle uses the road as well. Open fields extending for 100 m or more lie on both sides of the road. The test section slopes gently upward toward the south end. The majority of the traffic traverses the entire length of the segment, but an occasional vehicle either enters or exits at two infrequently used intersections.

In November 1979 a Monsanto fabric was installed in the southernmost 305-m (1,000-ft) section by Ft. Carson construction crews under Monsanto supervision. The northern section is being used as a control section.

Test results

Field tests of ambient particulate concentrations around the test road were conducted in November 1979 and April 1980. The test apparatus consisted of upwind and downwind stations equipped with Hi-Vols and dichotomous samplers in November and Hi-Vols and size selective Hi-Vols in April, Figure 2. The data derived from the Hi-Vol measurements are shown in Table 2. The lower increase in ambient concentration downwind of the fabric-plus-aggregate road is shown by comparison to the increase across the control section. The fabric-plus-aggregate road gave an average of 47 percent lower emissions within a range of 30 to 70 percent lower emissions.

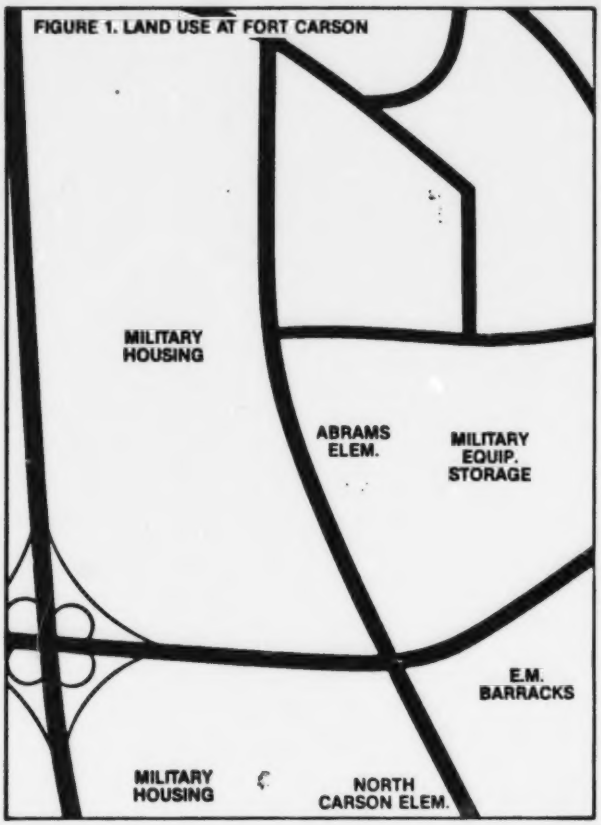

FIGURE 1. LAND USE AT FORT CARSON

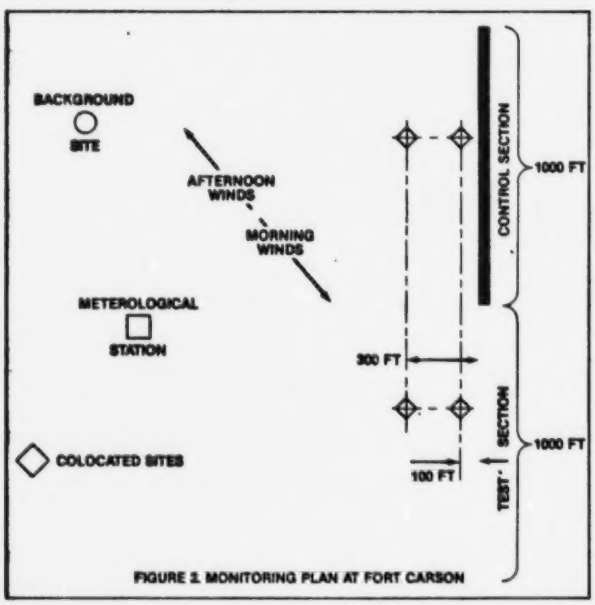

FIGURE 2. MONITORING PLAN AT FORT CARSON

Wind speeds during November were lower than during April which corresponded to greater emissions reductions during November than in April.

Data for the control of inhalable particles (those with diameters less than 15 μm) are shown in Table 3. As noted above, the November data was derived from dichotomous sampler measurements and the April data from size selective Hi-Vol measurements. The percentage reduction shown in the table is again the lower increase in emissions from the fabric/aggregate road as compared to the control road. The reduction averaged 43 percent within a range of 26 to 53 percent. Again the reduction was slightly greater with lower wind speeds.

These results may be used to compare the cost effectiveness of civil engineering fabrics for unpaved road control to other methods as shown in Table 4. Based on cost estimated by Cooper[1] and Blackwood,[2] the other methods have a cost of at least $220 to $300 for each kilometer of road/year/percent reduction in emissions. For fabric/aggregate roads, the cost is $140/km/yr/percent reduction. Thus, the fabric/aggregate road is more cost-effective and avoids the problem of availability of water in arid regions for watering or that of oil runoff for oiling.

Future monitoring plan

The current plan calls for a 1-yr study to collect data on the following parameters: total suspended particulate, size fraction under 15 μm, vehicle counts, precipitation, and wind speed/direction. Five pairs of Hi-Vols/Hi-Vol with size selective inlets are to be used. Because the predominant winds are drainage winds which are diurnal in nature, from the northwest in the morning and southeast in the afternoon, the monitor pairs are located north of the center point of each test section and should measure mainly upslope afternoon emissions. A background site will be located far enough away so as not to be affected by road emissions.

Instruments will be maintained and filters weighed by the local health department which conducts the TSP monitoring for the state and is cognizant of EPA quality assurance procedures. Samples will be taken every 6 days to correspond to the sampling schedule for other Hi-Vols in the area. Because of the heavy filter loadings, 4- or 8-hr samples may be taken instead of the normal 24-hr sample.

All data collected will be submitted to the EPA Regional Office for analysis. A final report should be available late in 1981. **PE**

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Table 3. CONTROL EFFICIENCY OF ROAD CARPET (BIDIM) FOR INHALABLE PARTICLES

Date	Wind Speed, mph	% Reduction
11/7/79	0.6	53
11/9/79	2.4	31
11/13/79	1.5	49
11/16/79	0.2	48
4/28/80	7	45
4/28/80	7	39
4/29/80	8	26
4/29/80	9	49
Average		43

Table 4. COSTS OF UNPAVED ROAD CONTROL

Method	Efficiency, %	by Cooper[1]	by Blackwood[2]	$km/yr/%
Oiling	50-98	up to 180,000	11,000	220-1800
Watering	40	25,000-39,000	11,500	290-1000
$CaCl_2$	60	18,000	---	300
Road carpet	45	---	6,000	140